The NOAA Environmental Modeling System (NEMS)

N
C
E
P

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Environmental Modeling Center

NOAA/NWS/NCEP

The EMC Mission…..

In response to operational requirements:

- **Develop and Enhance numerical guidance**
  - Improve NCEP's numerical forecast model systems via:
    - Scientific upgrades
    - Optimization
    - Additional observations

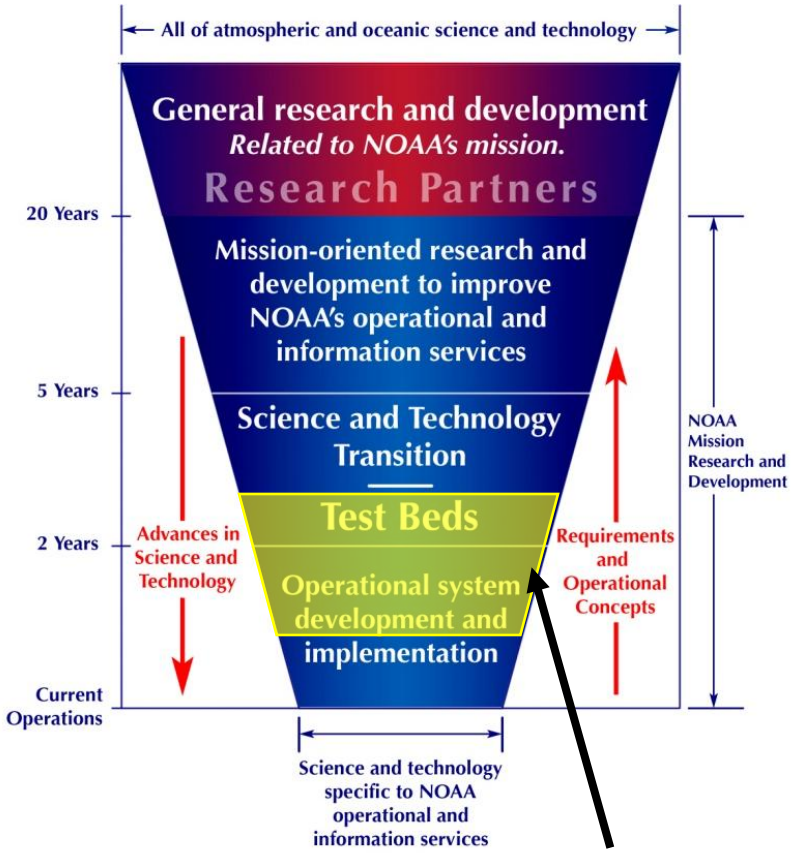
45%

- **Transition operational numerical forecast models from research to operations**
  - Transform & integrate
    - Code
    - Algorithms
    - Techniques
  - Manages and executes transition process including technical and system performance review before implementation

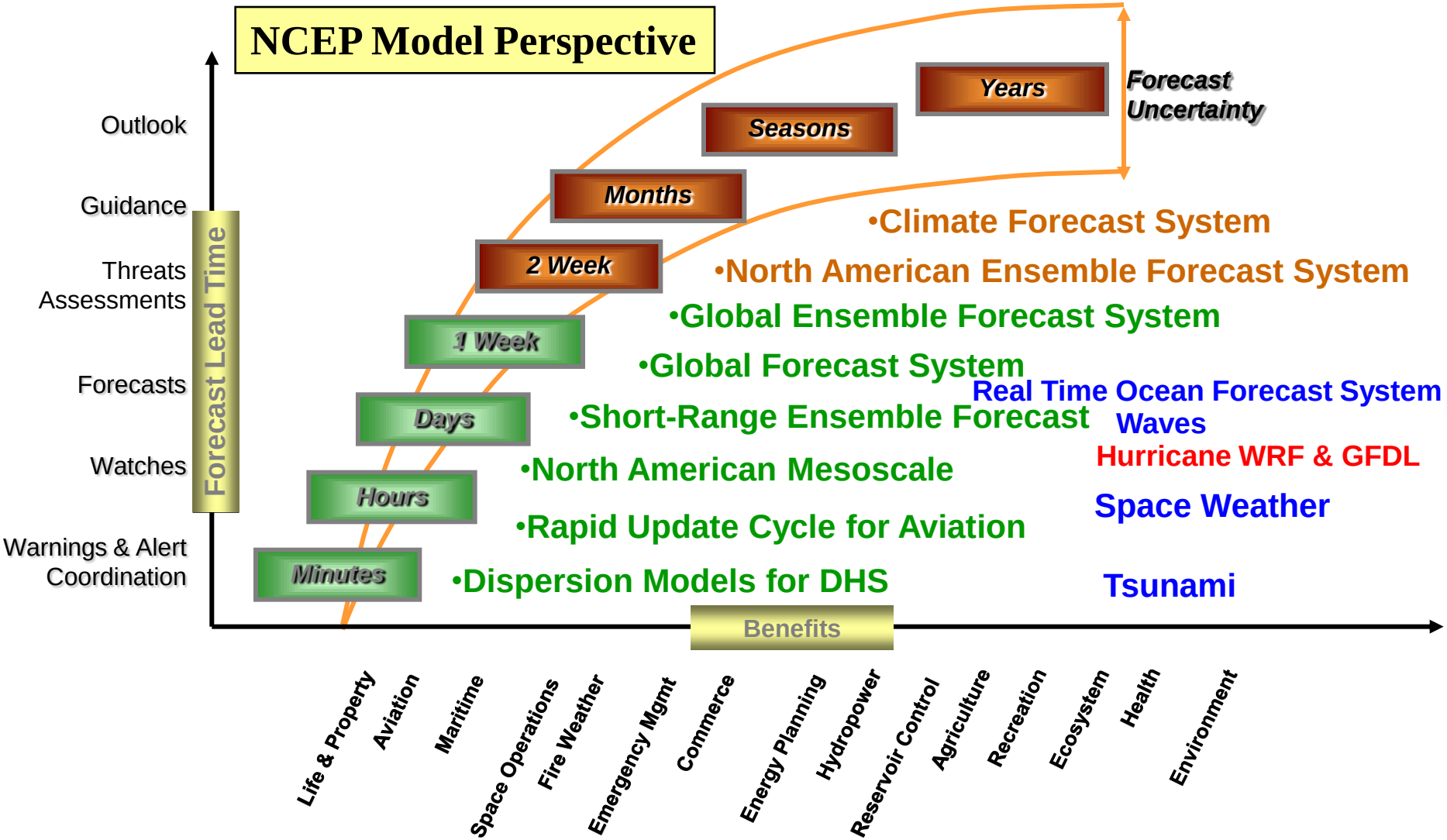
30%

- **Maintain operational model suite**
  - The scientific correctness and integrity of operational forecast modeling systems
  - Modify current operational system to adapt to ever-present external changes

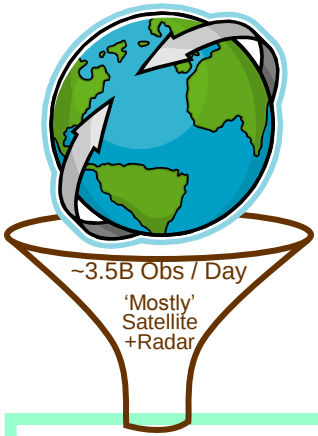
25%



NWS Seamless Suite of Forecast Products Spanning Weather and Climate



Linkage of Model Systems Within Production Suite

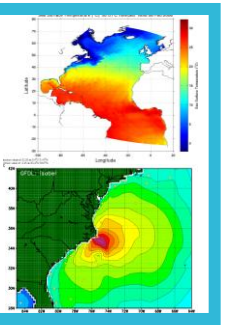


CLIMATE CFS
GFS + MOM3/4

Hurricane
GFDL
HWRF (**NMM**)

Coupled

Oceans
HYCOM
WaveWatch III

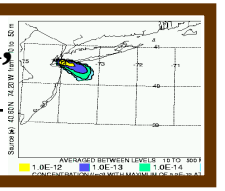


Global Data Assimilation

Global Forecast System

North American Mesoscale
NMM

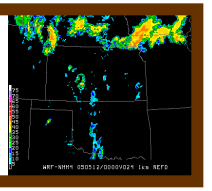
Dispersion, Ash, Smoke & Dust
ARL's HYSPLIT



Regional Data Assimilation

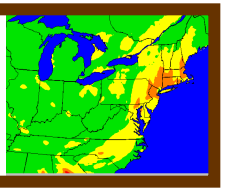
Short-Range Ensemble Forecast
NMM + ARW + ETA + RSM

Severe Weather
NMM + ARW



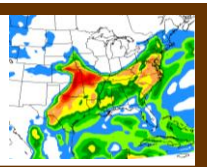
North American Ensemble Forecast System
GFS + Canadian Global +…

Air Quality
NAM + EPA/ ARL's CMAQ



Very Short Range Ensemble Forecasts
Time-Lagged RUC+NAM

Rapid Update for Aviation
GSD's RUC



NOAA Environmental Modeling System

- **A shared, portable, high performance software superstructure and infrastructure**
- **For use in operational prediction models at National Centers for Environmental Prediction (NCEP)**
- **National Unified Operational Prediction Capability (NUOPC) with Navy and Air Force**
- **Eventual support to community through Developmental Test Center (DTC)**
- **http://www.emc.ncep.noaa.gov/NEMS/**

Motivation for NEMS

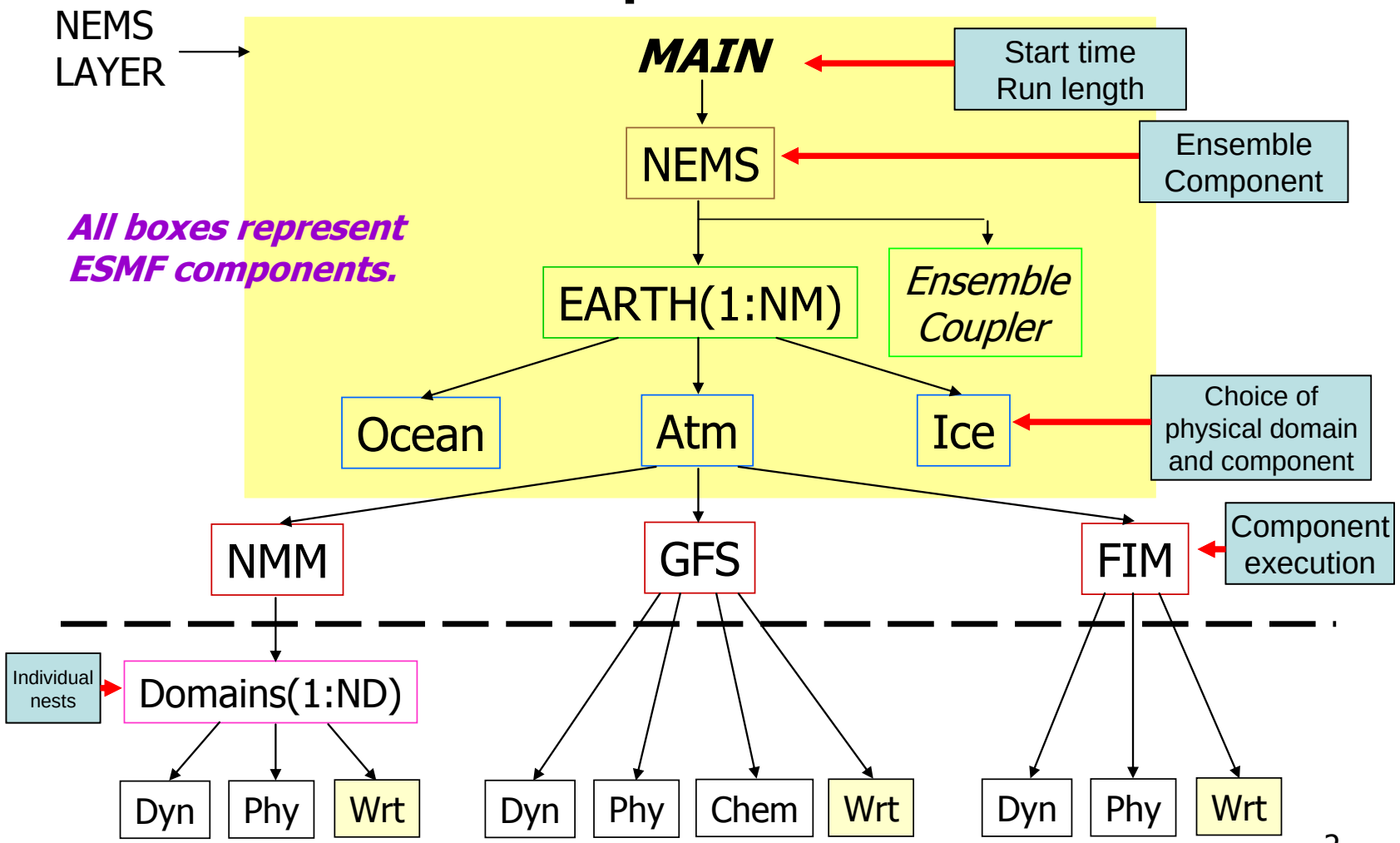
- **Develop a common superstructure for all NCEP models**
- **Modularize large pieces of the models with ESMF components and interfaces**
- **Divide atmospheric models down into Dynamics and Physics components but no further**
- **Take history file I/O outside the science parts and into a common Write component**
- **Keep science code and parallelization code in the respective models the same as before**

NEMS Project Developers

Tom Black Dusan Jovic Jim Abeles	NAM
S Moorthi Henry Juang	GFS
Jesse Meng Jim Geiger	Land
Sarah Lu Arlindo da Silva	GOCART
Tom Henderson Jim Rosinski	FIM
Eugene Mirvis	DTC

NOAA Environmental Modeling System (NEMS)

NEMS Component Structure



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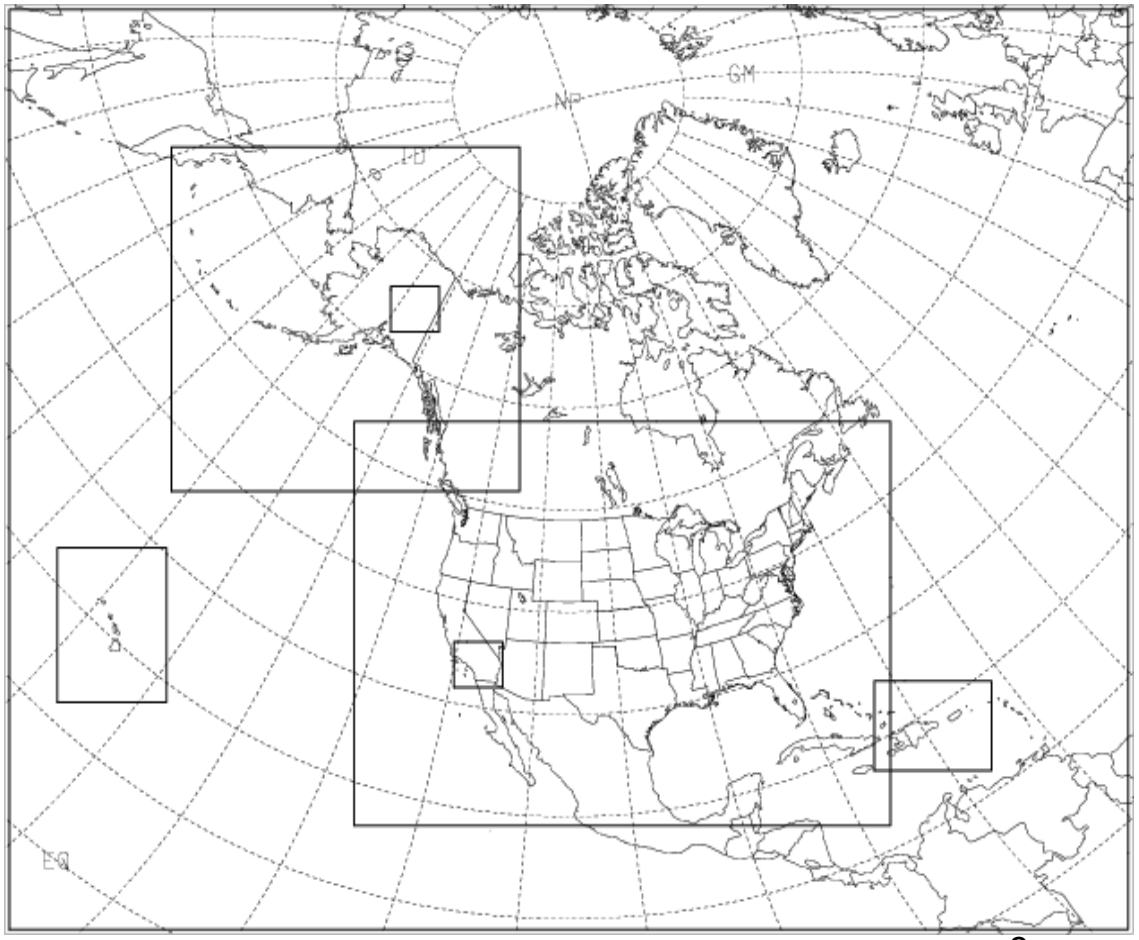
Below the dashed line the source codes are organized by the model developers.

Operational Implementation Q3FY11

- 12 km NAM will still run to 84 hr
- Fixed domain nests run to 60 hr
  - 4 km CONUS
  - 6 km Alaska
  - 3 km HI & PR
- Single locatable 1.33 km (CONUS) or 1.5 km (Alaska) nest to 36hr
- Nests
  - Static, 1-way
  - Boundaries from parent every timestep
  - Nest is “grid-associated” with parent (same orientation w.r.t. earth)
  - Moving nests and 2-way interaction under development



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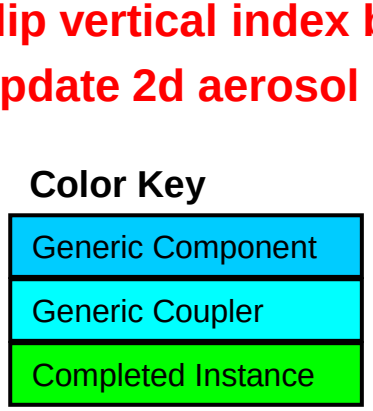
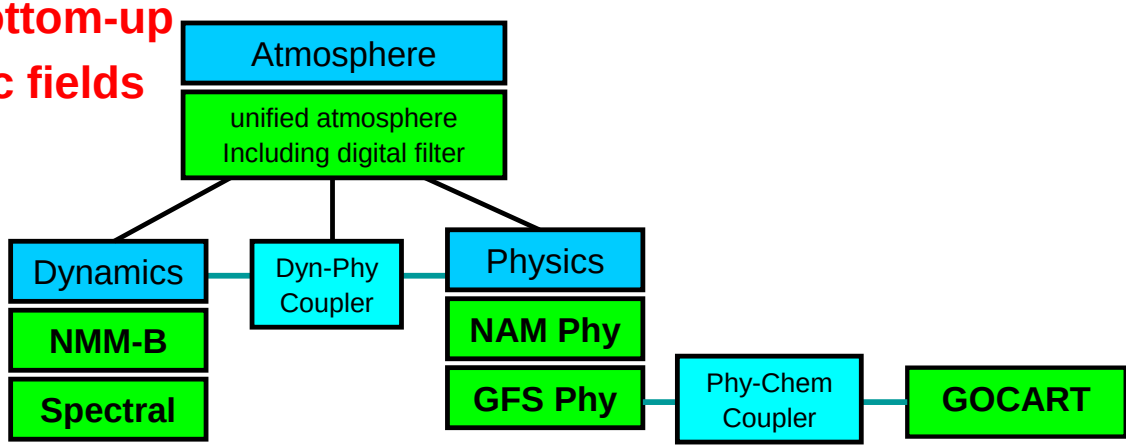
NEMS GFS Aerosol Component (NGAC)

- Dynamics, physics and chemistry run on the same grid in the same decomposition
- GOCART does not own aerosol tracers (i.e, do not allocate aerosol tracer fields)
- PHY2CHEM coupler component transfers/converts data from physics export state to GOCART import state
  - Convert units (e.g., precip rate, surface roughness)
  - Calculations (e.g., soil wetness, tropopause pressure, relative humidity, air density, geopotential height)
  - Flip the vertical index for 3D fields from bottom-up to top-down
- CHEM2PHY coupler component transfers data from GOCART export state to physics export state
  - Flip vertical index back to bottom-up
  - Update 2d aerosol diagnostic fields



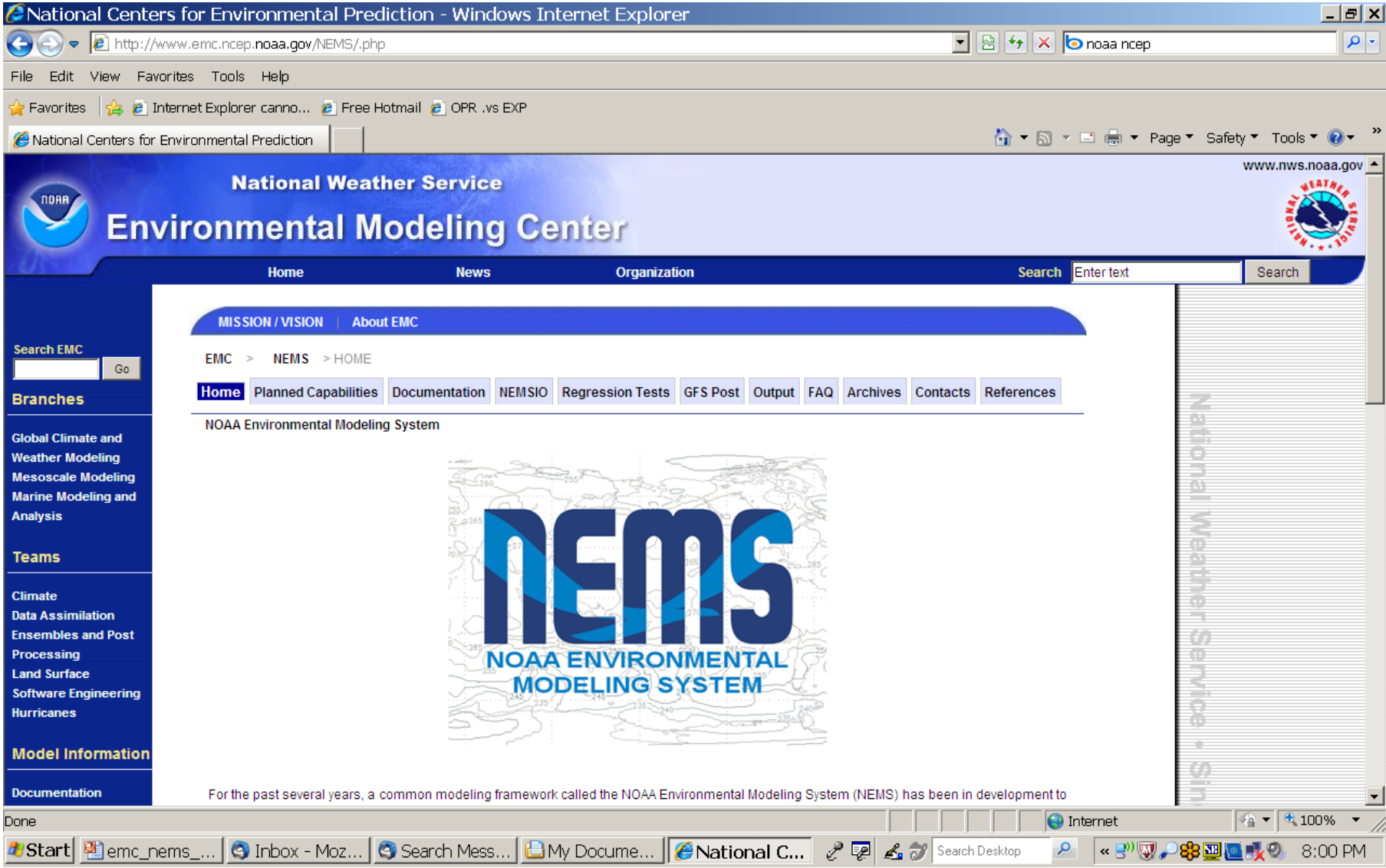


NEMS Delivery Plans

- **2011**
  - **GFS**
  - **GEFS**
  - **Postprocessor**
  - **FIM**
  - **Multimodel ensemble**
  - **GRIB2 output**

- **2012+**
  - **NMM nested in GFS**
  - **Moving nests**
  - **Coupled ocean atmosphere**
  - **Tiled land model**
  - **netCDF output**
  - **ARW**

Questions Welcome



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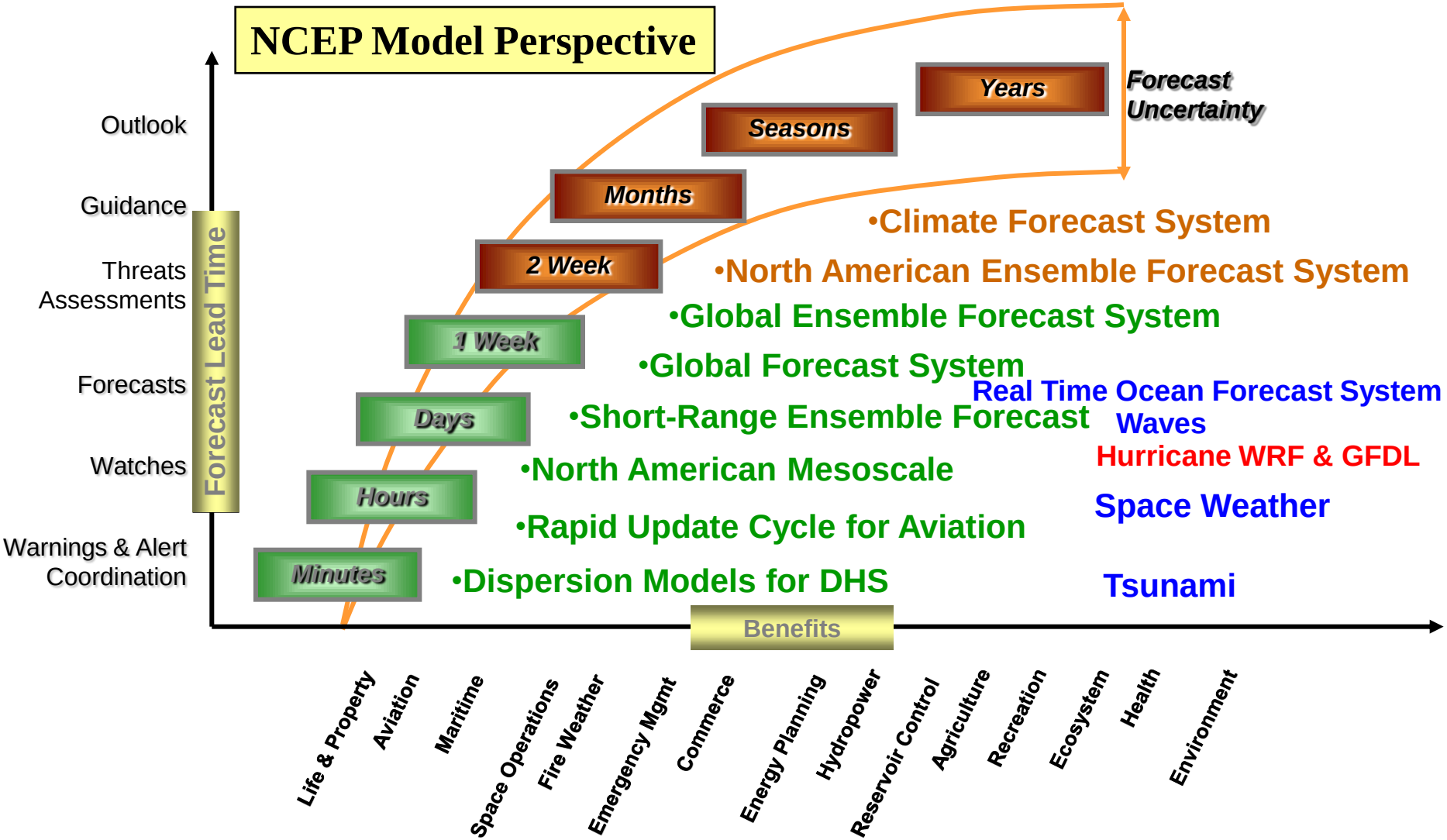
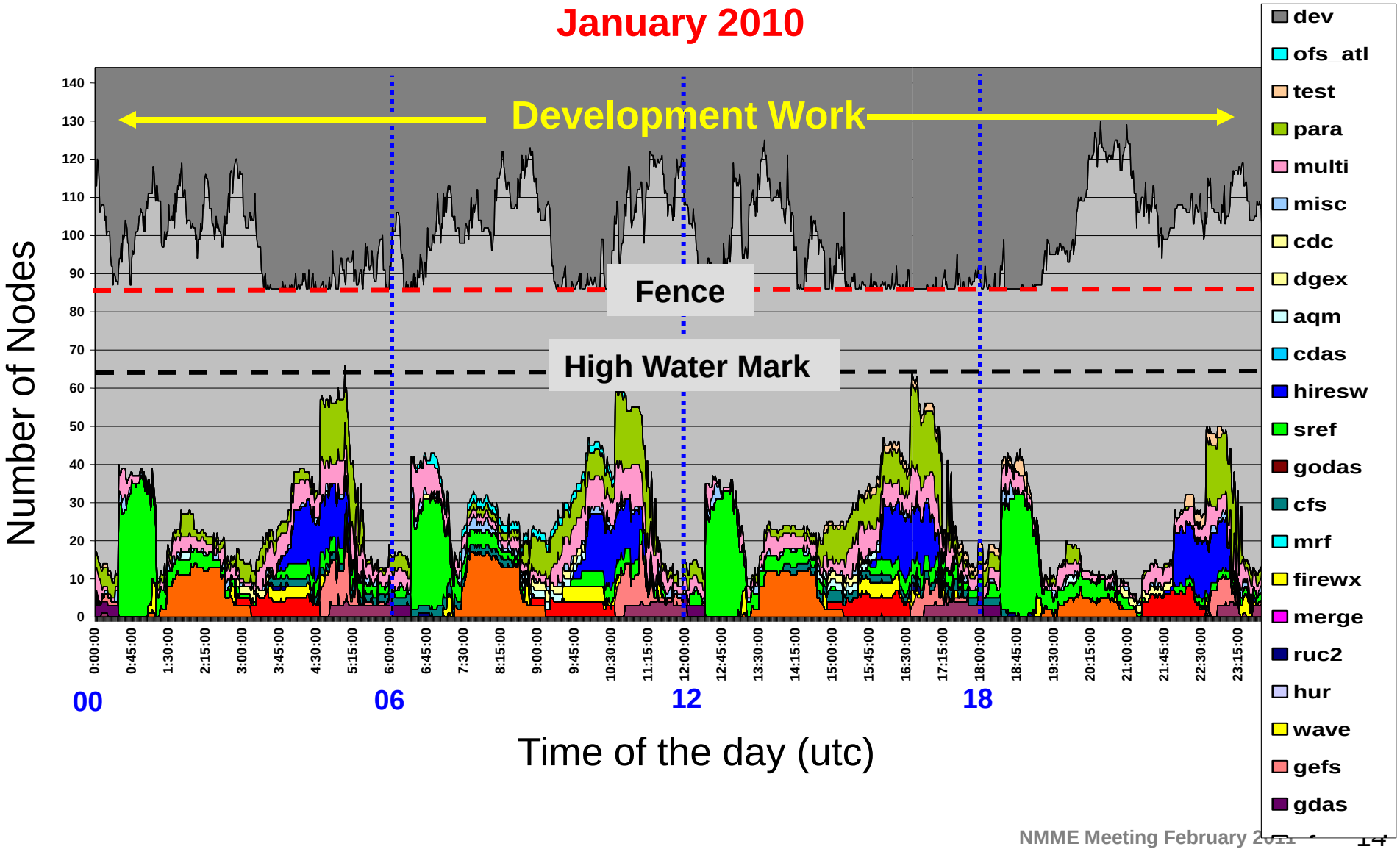


Production Suite on Supercomputer



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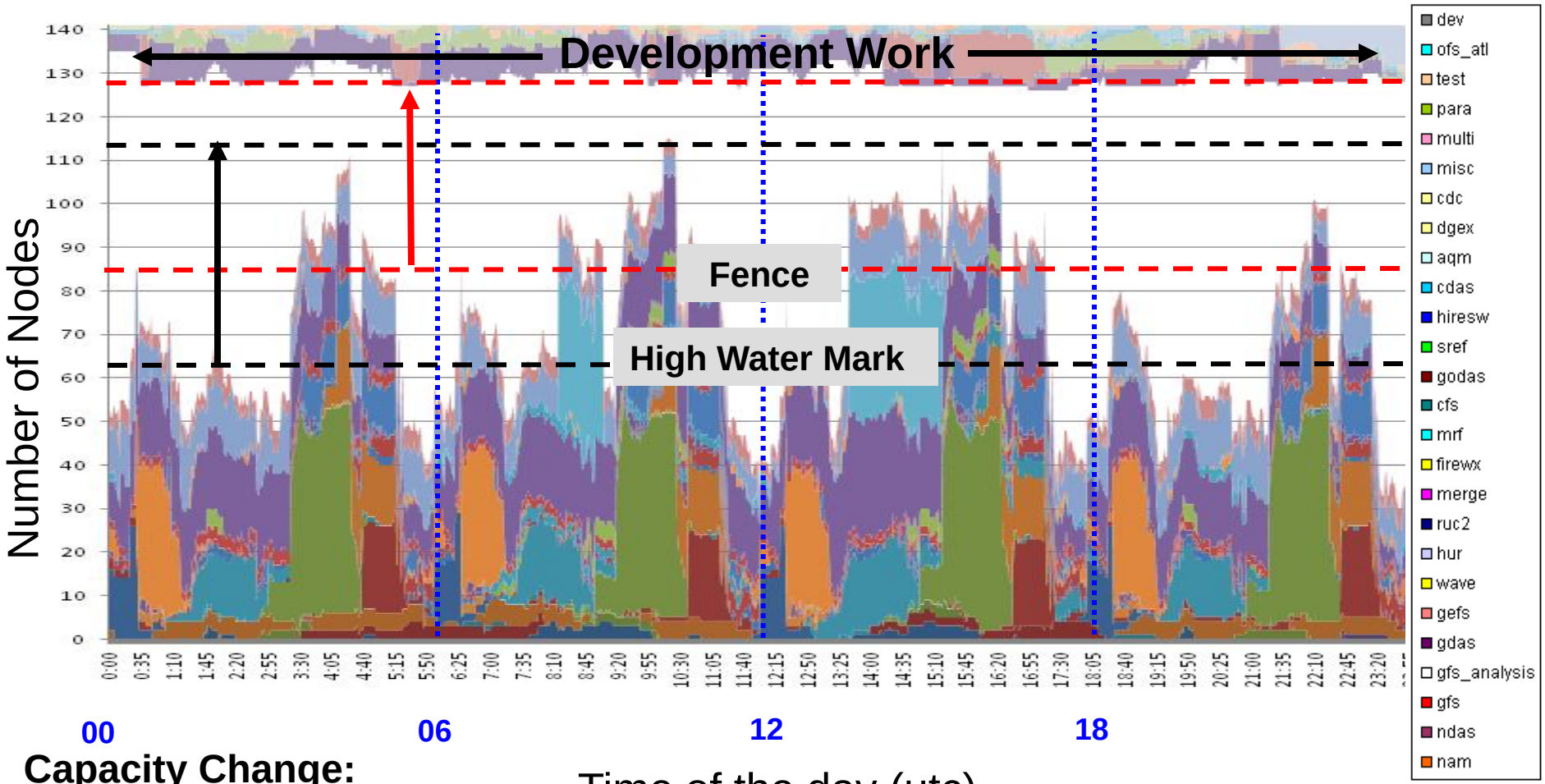
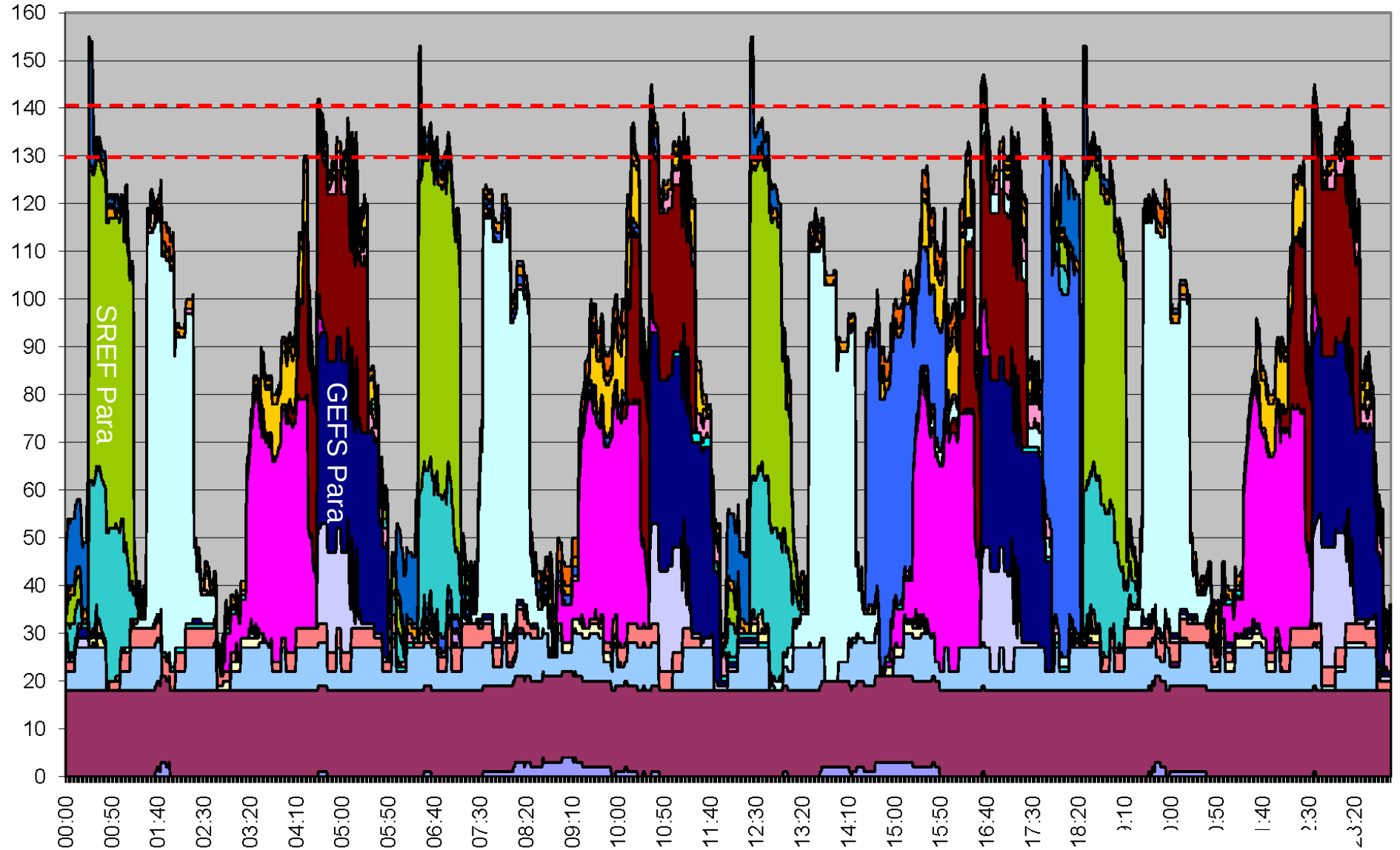


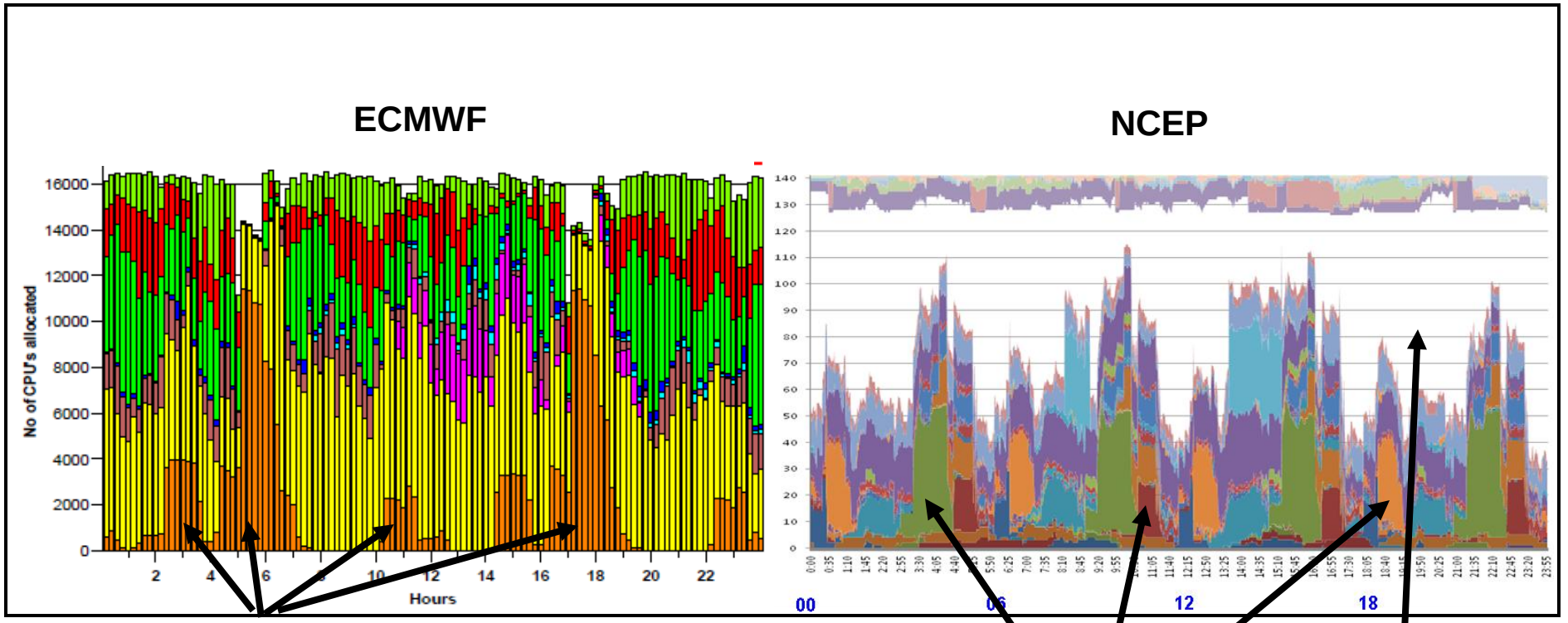
Capacity Change:
50% increase in production
80% decrease in development

Mid Q3 FY11
Includes: GEFS Prod & Para, SREF Prod & Para, 37 nodes for HRW/Hurricanes



Comparison of the NCEP and ECMWF Production Suites from a Computational Perspective……

CPU Utilization for 24 Hour Cycle of Production Suite on IBM P6



Operational Production Suite

ECMWF: 2 cycles/day; NCEP 4 cycles/day

NCEP: note complexity of production suite (many colors)

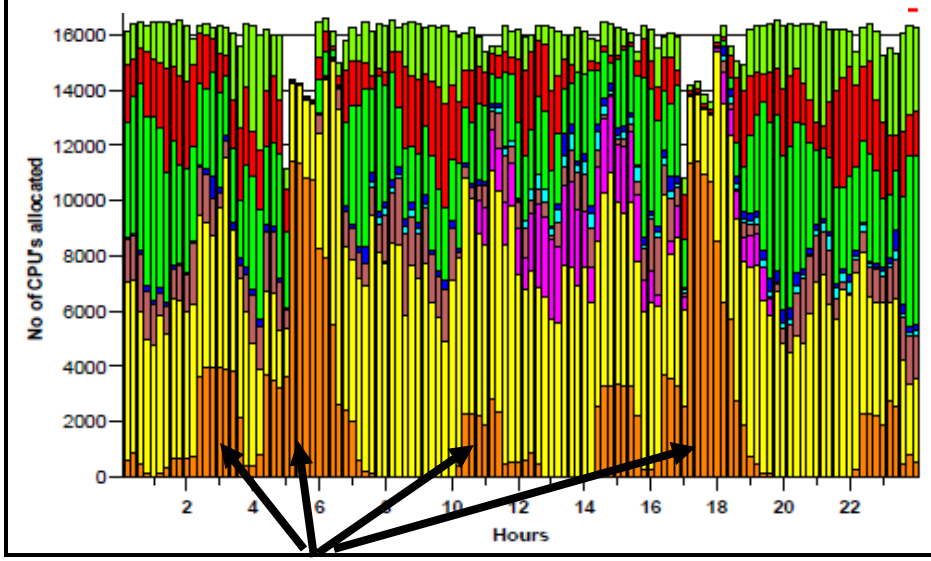
ECMWF: fills the "valleys" in production; NCEP developing capability

Comparison of the NCEP and ECMWF Production Suites from a Computational Perspective……

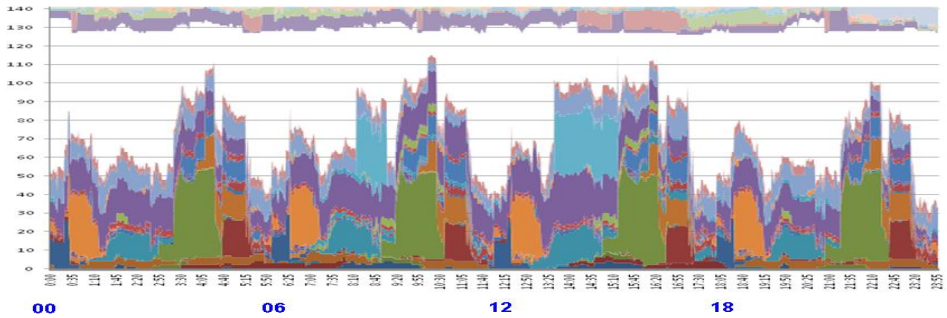
CPU Utilization for 24 Hour Cycle of Production Suite on IBM P6

With compute capacity scaled……

ECMWF



NCEP



Operational Production Suite

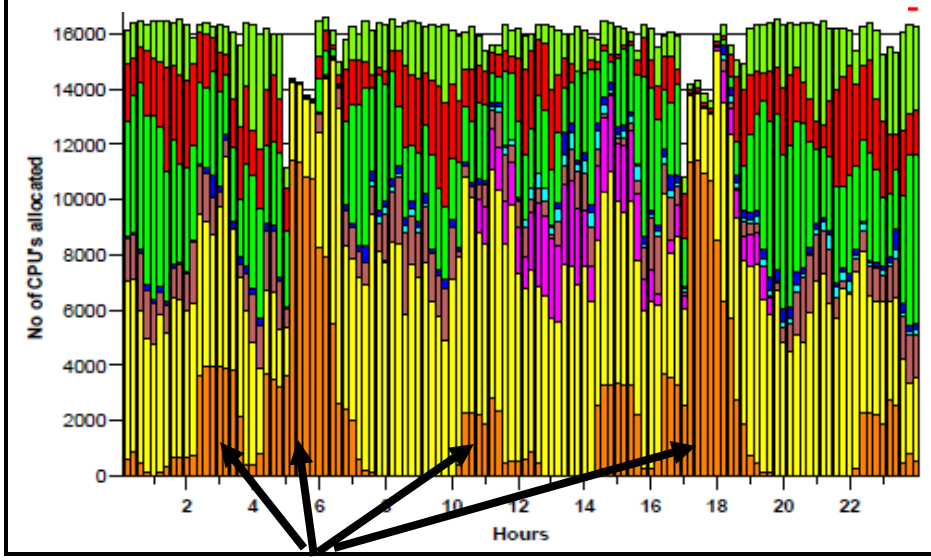
ECMWF: High water mark is ~210 nodes (EPS)
NCEP: maximum available for production ~132 nodes
NCEP: High water mark is ~ 110 nodes

Comparison of the NCEP and ECMWF Production Suites from a Computational Perspective……

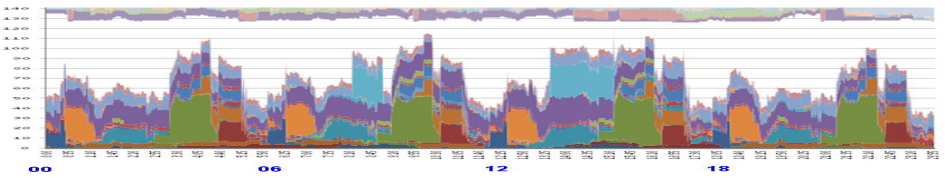
CPU Utilization for 24 Hour Cycle of Production Suite on IBM P6

ECMWF to a IBM P7 in late FY11…….

ECMWF



NCEP



Operational Production Suite

ECMWF: High water mark is ~210 nodes (EPS)
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NCEP: High water mark is ~ 110 nodes

NCEP Aggressively Porting Codes to Other Compute Centers

- **Current Porting Activities:**
  - HEVDAS development in Boulder
  - NASA—ARC, GSFC (JCSDA), projects
  - Benchmarks for computer acquisition
  - In discussion with NSF

- **Coming Attractions:**
  - NOAA Climate Computing at ORNL (GAEA)
  - NOAA R&D at Fairmont WV– First drop early FY12
  - Upgrade of Operational Compute in FY14

Schedule for NOAA Computing at ORNL CRAY XT6 (GAEA)

Milestone Date	System Configuration/Milestone	CPU Cores	Tflops	Memory Per Core (GB)
October '10	CMRS.1 Available to Users	~31,000	260	~2.67
October '11	CMRS.2 Available to Users	~78,000	720	2.0
Oct '11 – Feb '12	***CMRS.1 + CMRS.2***	***~109,000***	***980***	
February '12	CMRS.1 Upgrade	~41,000	386	2.0
Feb'12 – Sep'14	***Final CMRS Configuration***	***119,000***	***1,106***	***2.0***